bdiGDB

JTAG debug interface for GNU Debugger

PowerPC 4xx

User Manual

Manual Version 1.16 for BDI2000

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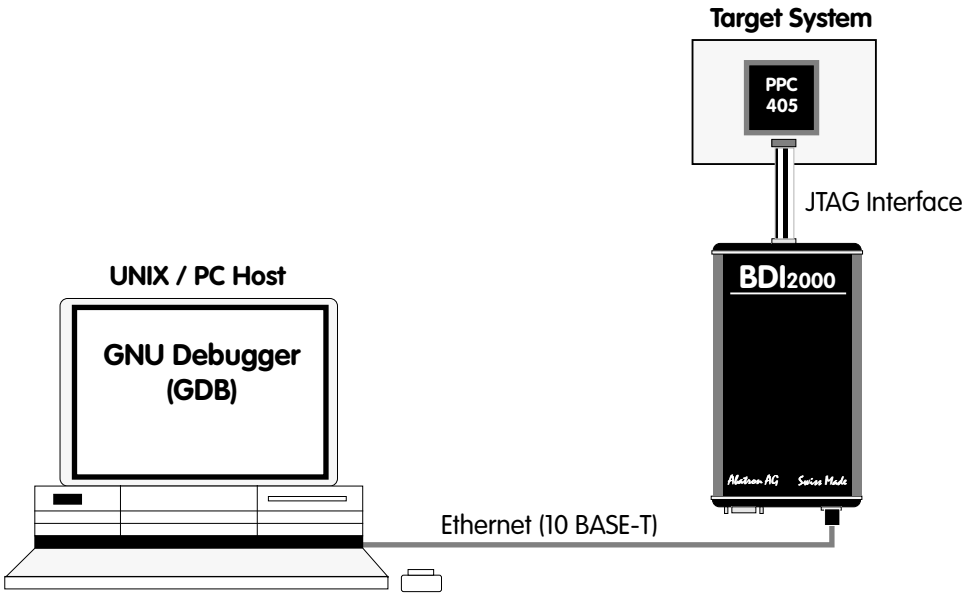
1 Introduction

bdiGDB enhances the GNU debugger (GDB), with JTAG debugging for PowerPC 4xx based targets. With the built-in Ethernet interface you get a very fast code download speed. No target communication channel (e.g. serial line) is wasted for debugging purposes. Even better, you can use fast Ethernet debugging with target systems without network capability. The host to BDI communication uses the standard GDB remote protocol.

An additional Telnet interface is available for special debug tasks (e.g. force a hardware reset, program flash memory).

The following figure shows how the BDI2000 interface is connected between the host and the target:



1.1 BDI2000

The BDI2000 is the main part of the bdiGDB system. This small box implements the interface between the JTAG pins of the target CPU and a 10Base-T Ethernet connector. The firmware and the programmable logic of the BDI2000 can be updated by the user with a simple Windows based configuration program. The BDI2000 supports 1.8 – 5.0 Volts target systems (3.0 – 5.0 Volts target systems with Rev. B).

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1.2 BDI Configuration

As an initial setup, the IP address of the BDI2000, the IP address of the host with the configuration file and the name of the configuration file is stored within the flash of the BDI2000.
Every time the BDI2000 is powered on, it reads the configuration file via TFTP.

Following an example of a typical configuration file:

```
;bdiGDB configuration file for IBM 405GP Reference Board
; ------------------------------------------------------
;
[INIT]
; init core register
WSPR    954     0x00000000;DCWR: Disable data cache write-thru
WSPR    1018    0x00000000;DCCR: Disable data cache
WSPR    1019    0x00000000;ICCR: Disable instruction cache
WSPR    982     0x00000000;EVPR: Exception Vector Table @0x00000000
; Setup Peripheral Bus
WDCR    18      0x00000010;Select PB0AP
WDCR    19      0x9B015480;PB0AP: Flash and SRAM
WDCR    18      0x00000000;Select PB0CR
WDCR    19      0xFFF18000;PB0CR: 1MB at 0xFFF00000, r/w, 8bit
; Setup SDRAM Controller
WDCR    16      0x00000080;Select SDTR1
WDCR    17      0x0086400D;SDTR1: SDRAM Timing Register
WDCR    16      0x00000040;Select MB0CF
WDCR    17      0x00046001;MB0CF: 16MB @ 0x00000000
WDCR    16      0x00000048;Select MB2CF
WDCR    17      0x01046001;MB2CF: 16MB @ 0x01000000
WDCR    16      0x00000030;Select RTR
WDCR    17      0x05F00000;RTR: Refresh Timing Register
WDCR    16      0x00000020;Select MCOPT1
WDCR    17      0x80800000;MCOPT1: Enable SDRAM Controller

[TARGET]
JTAGCLOCK   0         ;use 16 MHz JTAG clock
CPUTYPE     405       ;the used target CPU type
BDIMODE     AGENT     ;the BDI working mode (LOADONLY | AGENT)
BREAKMODE   SOFT      ;SOFT or HARD, HARD uses PPC hardware breakpoint
VECTOR      CATCH     ;catch unhandled exceptions

[HOST]
IP          151.120.25.115
FILE        E:\cygnus\root\usr\demo\evb405\vxworks
FORMAT      ELF
LOAD        MANUAL      ;load code MANUAL or AUTO after reset
DEBUGPORT   2001

[FLASH]
WORKSPACE   0x00004000  ;workspace in target RAM for fast programming algorithm
CHIPTYPE    AM29F       ;Flash type (AM29F | AM29BX8 | AM29BX16 | I28BX8 | I28BX16)
CHIPSIZE    0x80000     ;The size of one flash chip in bytes (e.g. AM29F040 = 0x80000)
BUSWIDTH    8           ;The width of the flash memory bus in bits (8 | 16 | 32)
FILE        E:\cygnus\root\usr\demo\evb405\evb405gp.hex  ;The file to program
ERASE       0xFFF80000  ;erase sector 0 of flash in U7 (AM29F040)
ERASE       0xFFF90000  ;erase sector 1 of flash
```

Based on the information in the configuration file, the target is automatically initialized after every reset.

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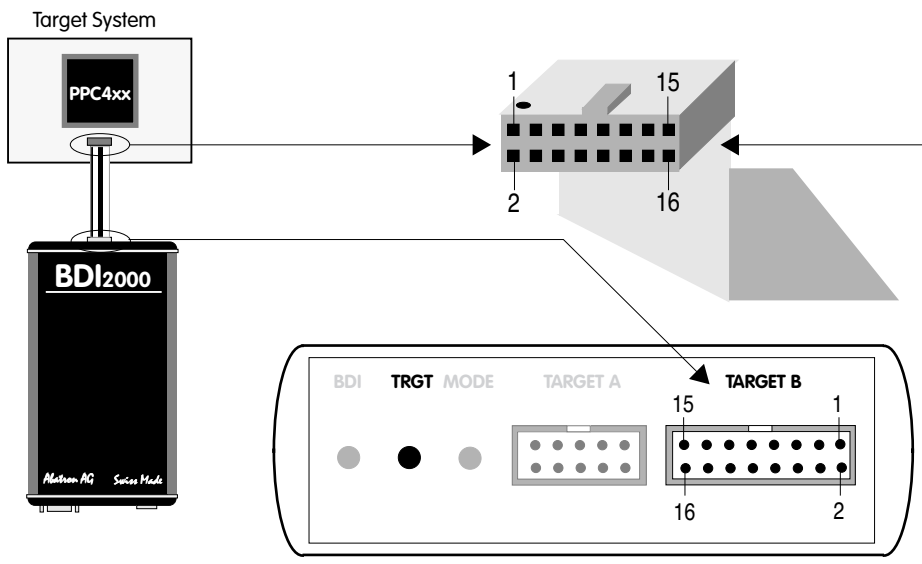
2 Installation

2.1 Connecting the BDI2000 to Target

The cable to the target system is a 16 pin flat ribbon cable. In case where the target system has an appropriate connector, the cable can be directly connected. The pin assignment is in accordance with the PowerPC 4xx JTAG connector specification.

In order to ensure reliable operation of the BDI (EMC, runtimes, etc.) the target cable length must not exceed 20 cm (8").



The green LED «TRGT» marked light up when target is powered up

JTAG Connector

1 - TDO
2 - NC
3 - TDI
4 - $\overline{\text{TRST}}$
5 - NC
6 - Vcc Target
7 - TCK
8 - NC
9 - TMS
10 - NC
11 - $\overline{\text{HALT}}$
12 - NC (GROUND)
13 - $\overline{\text{RESET}}$
14 - NC (key)
15 - NC
16 - GROUND

For BDI TARGET B connector signals see table on next page.

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BDI TARGET B Connector Signals:

Pin	Name	Describtion
1	TDO	**JTAG Test Data Out** This input to the BDI2000 connects to the target TDO pin.
2	<reserved>	
3	TDI	**JTAG Test Data In** This output of the BDI2000 connects to the target TDI pin.
4	$\overline{\text{TRST}}$	**JTAG Test Reset** This output of the BDI2000 resets the JTAG TAP controller on the target.
5	<reserved>	
6	Vcc Target	**1.8 – 5.0V:** This is the target reference voltage. It indicates that the target has power and it is also used to create the logic-level reference for the input comparators. It also controls the output logic levels to the target. It is normally fed from Vdd I/O on the target board. **3.0 – 5.0V with Rev. B :** This input to the BDI2000 is used to detect if the target is powered up. If there is a current limiting resistor between this pin and the target Vdd, it should be 100 Ohm or less.
7	TCK	**JTAG Test Clock** This output of the BDI2000 connects to the target TCK pin.
8	<reserved>	
9	TMS	**JTAG Test Mode Select** This output of the BDI2000 connects to the target TMS line.
10	<reserved>	
11	$\overline{\text{HALT}}$	**Processor Halt** This output of the BDI2000 connects to the target HALT line.
12	GROUND	**System Ground**
13	$\overline{\text{RESET}}$	**System Reset (optional)** This open collector output of the BDI2000 is used to hard reset the target system. This is an optional signal and only driven if RESET HARD is selected in the BDI configuration. The standard IBM debug connected specification does not include this signal.
14	<reserved>	
15	<reserved>	
16	GROUND	**System Ground**

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2.1.1 Changing Target Processor Type

Before you can use the BDI2000 with an other target processor type (e.g. CPU32 <--> PPC), a new setup has to be done (see chapter 2.5). During this process the target cable must be disconnected from the target system. The BDI2000 needs to be supplied with 5 Volts via the BDI OPTION connector (Version A) or via the POWER connector (Version B). For more information see chapter 2.2.1 «External Power Supply».

To avoid data line conflicts, the BDI2000 must be disconnected from the target system while programming the logic for an other target CPU.

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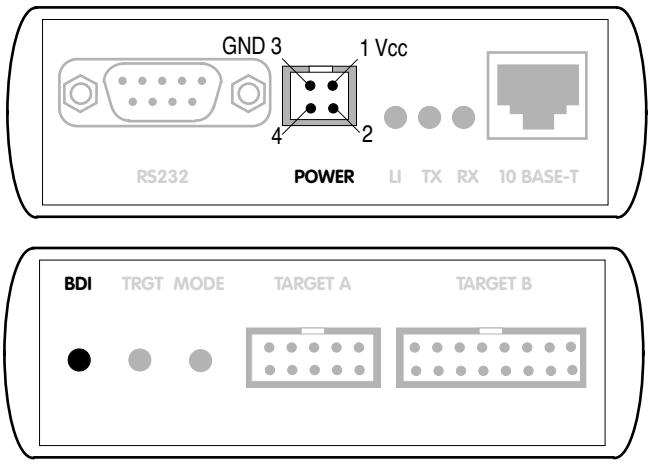
2.2 Connecting the BDI2000 to Power Supply

The BDI2000 needs to be supplied with 5 Volts (max. 1A) via the POWER connector. The available power supply from Abatron (option) or the enclosed power cable can be directly connected. In order to ensure reliable operation of the BDI2000, keep the power supply cable as short as possible.

For error-free operation, the power supply to the BDI2000 must be between 4.75V and 5.25V DC. **The maximal tolerable supply voltage is 5.25 VDC. Any higher voltage or a wrong polarity might destroy the electronics.**



POWER Connector

1 - Vcc (+5V)
2 - VccTGT
3 - GROUND
4 - NOT USED

The green LED «BDI» marked light up when 5V power is connected to the BDI2000

Please switch on the system in the following sequence:

- 1 --> external power supply
- 2 --> target system

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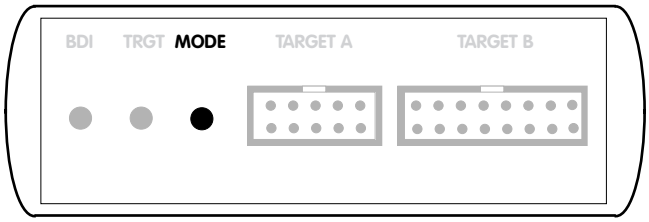
2.3 Status LED «MODE»

The built in LED indicates the following BDI states:



MODE LED	BDI STATES
OFF	The BDI is ready for use, the firmware is already loaded.
ON	The power supply for the BDI2000 is < 4.75VDC.
BLINK	The BDI «loader mode» is active (an invalid firmware is loaded or loading firmware is active).

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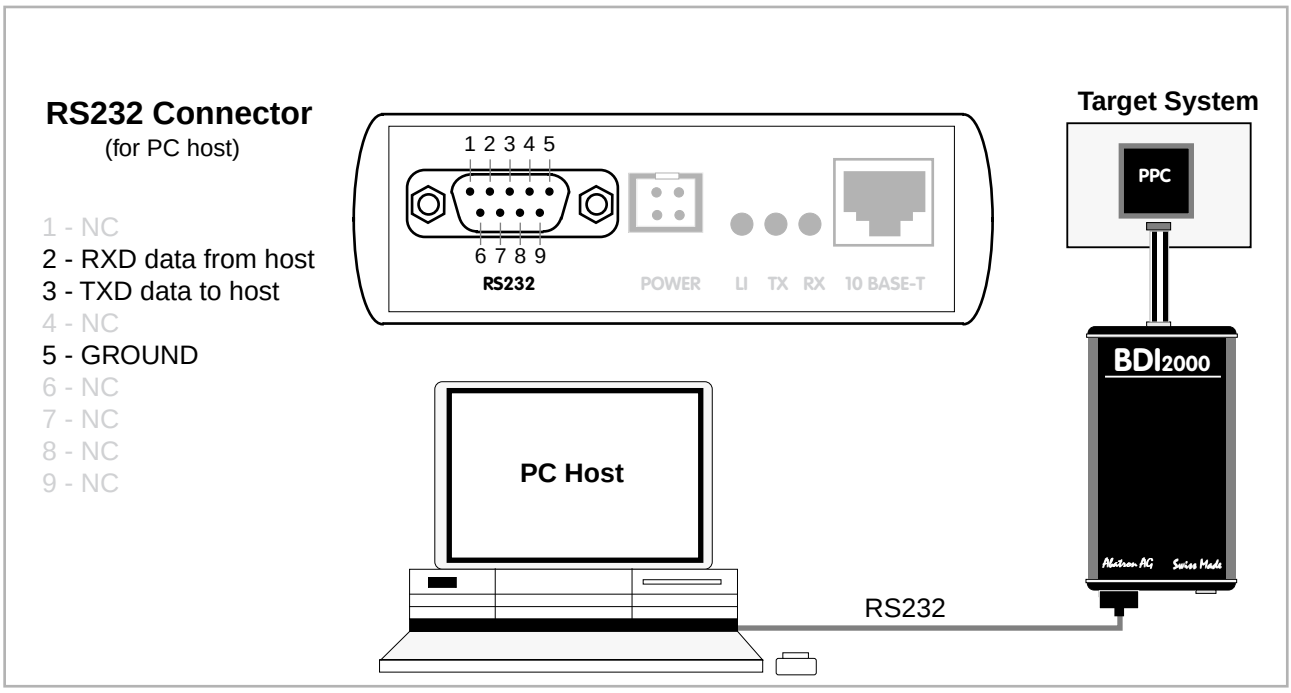
2.4 Connecting the BDI2000 to Host

2.4.1 Serial line communication

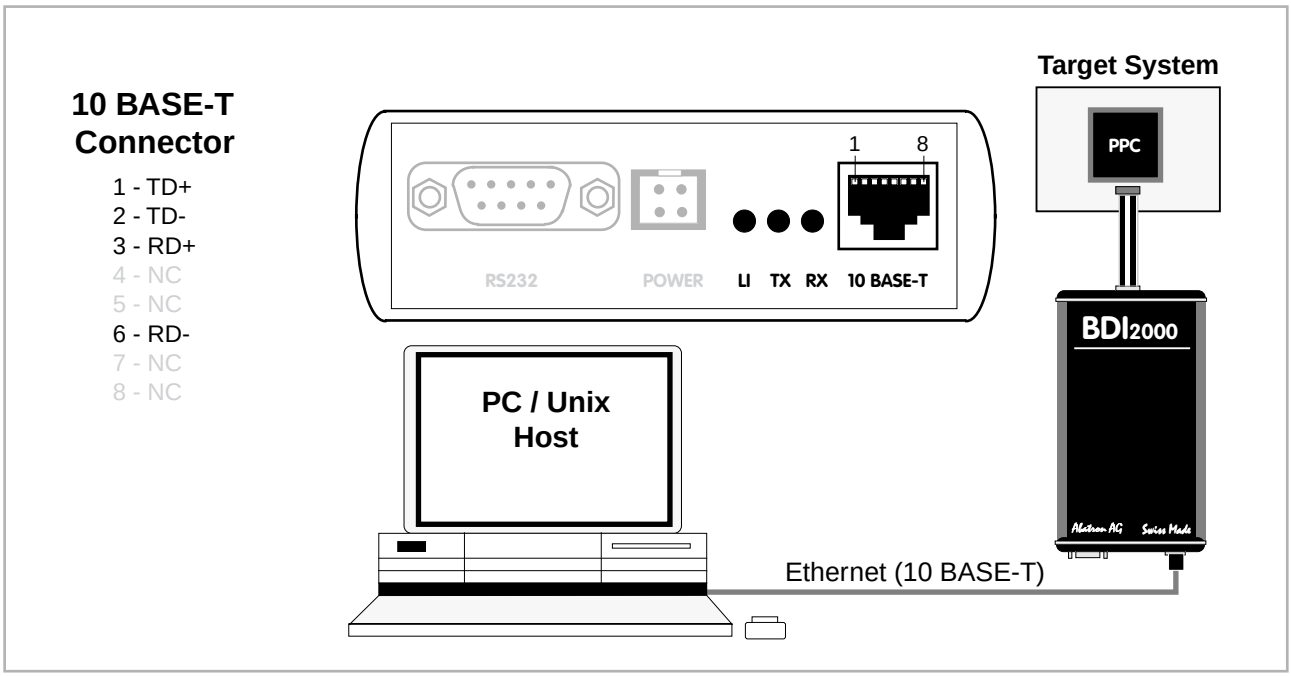
Serial line communication is only used for the initial configuration of the bdiGDB system.

The host is connected to the BDI through the serial interface (COM1...COM4). The communication cable (included) between BDI and Host is a serial cable. There is the same connector pinout for the BDI and for the Host side (Refer to Figure below).



2.4.2 Ethernet communication

The BDI2000 has a built-in 10 BASE-T Ethernet interface (see figure below). Connect an UTP (Unshilded Twisted Pair) cable to the BD2000. For thin Ethernet coaxial networks you can connect a commercially available media converter (BNC-->10 BASE-T) between your network and the BDI2000. Contact your network administrator if you have questions about the network.



The following explains the meanings of the built-in LED lights:

LED	Name	Description
LI	Link	When this LED light is ON, data link is successful between the UTP port of the BDI2000 and the hub to which it is connected.
TX	Transmit	When this LED light BLINKS, data is being transmitted through the UTP port of the BDI2000
RX	Receive	When this LED light BLINKS, data is being received through the UTP port of the BDI2000

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2.5 Installation of the Configuration Software

On the enclosed diskette you will find the BDI configuration software and the firmware required for the BDI2000. For Windows users there is also a TFTP server included.

The following files are on the diskette.

b20pp4gd.exe	Windows Configuration program
b20pp4gd.hlp	Windows help file for the configuration program
b20pp4gd.xxx	Firmware for the BDI2000
pp4jed20.xxx	JEDEC file for the BDI2000 (Rev. B) logic device
pp4jed21.xxx	JEDEC file for the BDI2000 (Rev. C) logic device
tftpsrv.exe	TFTP server for Windows (WIN32 console application)
*.cfg	Configuration files
*.def	Register definition files
bdisetup.zip	ZIP Archive with the Setup Tool sources for Linux / UNIX hosts.

Overview of an installation / configuration process:

- Create a new directory on your hard disk
- Copy the entire contents of the enclosed diskette into this directory
- Linux only: extract the setup tool sources and build the setup tool
- Use the setup tool to load/update the BDI firmware/logic
  Note: A new BDI has no firmware/logic loaded.
- Use the setup tool to transmit the initial configuration parameters
  - IP address of the BDI.
  - IP address of the host with the configuration file.
  - Name of the configuration file. This file is accessed via TFTP.
  - Optional network parameters (subnet mask, default gateway).

Activating BOOTP:
The BDI can get the network configuration and the name of the configuration file also via BOOTP. For this simple enter 0.0.0.0 as the BDI's IP address (see following chapters). If present, the subnet mask and the default gateway (router) is taken from the BOOTP vendor-specific field as defined in RFC 1533.

With the Linux setup tool, simply use the default parameters for the -c option:

```
[root@LINUX_1 bdisetup]# ./bdisetup -c -p/dev/ttyS0 -b57
```

The MAC address is derived from the serial number as follows:
MAC: 00-0C-01-xx-xx-xx , repace the xx-xx-xx with the 6 left digits of the serial number
Example: SN# 93123457 ==>> 00-0C-01-93-12-34

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2.5.1 Configuration with a Linux / Unix host

The firmware / logic update and the initial configuration of the BDI2000 is done with a command line utility. In the ZIP Archive bdisetup.zip are all sources to build this utility. More information about this utility can be found at the top in the bdisetup.c source file. There is also a make file included.
Starting the tool without any parameter displays information about the syntax and parameters.

To avoid data line conflicts, the BDI2000 must be disconnected from the target system while programming the logic for an other target CPU (see Chapter 2.1.1).

Following the steps to bring-up a new BDI2000:

1. Build the setup tool:
The setup tool is delivered only as source files. This allows to build the tool on any Linux / Unix host. To build the tool, simply start the make utility.

```
[root@LINUX_1 bdisetup]# make
cc -O2   -c -o bdisetup.o bdisetup.c
cc -O2   -c -o bdicnf.o bdicnf.c
cc -O2   -c -o bdidll.o bdidll.c
cc -s bdisetup.o bdicnf.o bdidll.o -o bdisetup
```

2. Check the serial connection to the BDI:
With "bdisetup -v" you may check the serial connection to the BDI. The BDI will respond with information about the current loaded firmware and network configuration.
Note: Login as root, otherwise you probably have no access to the serial port.

```
[root@LINUX_1 bdisetup]# ./bdisetup -v -p/dev/ttyS0 -b57
BDI Type : BDI2000 Rev.C (SN: 92152150)
Loader   : V1.05
Firmware : unknown
Logic    : unknown
MAC      : 00-0c-01-92-15-21
IP Addr  : 255.255.255.255
Subnet   : 255.255.255.255
Gateway  : 255.255.255.255
Host IP  : 255.255.255.255
Config   : ????????????????????
```

3. Load/Update the BDI firmware/logic:
With "bdisetup -u" the firmware is loaded and the CPLD within the BDI2000 is programmed. This configures the BDI for the target you are using. Based on the parameters -a and -t, the tool selects the correct firmware / logic files. If the firmware / logic files are in the same directory as the setup tool, there is no need to enter a -d parameter.

```
[root@LINUX_1 bdisetup]# ./bdisetup -u -p/dev/ttyS0 -b57 -aGDB -tPPC400
Connecting to BDI loader
Erasing CPLD
Programming firmware with ./b20pp4gd.103
Programming CPLD with ./pp4jed21.101
```

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4. Transmit the initial configuration parameters:
With "bdisetup -c" the configuration parameters are written to the flash memory within the BDI.
The following parameters are used to configure the BDI:

BDI IP Address	The IP address for the BDI2000. Ask your network administrator for assigning an IP address to this BDI2000. Every BDI2000 in your network needs a different IP address.
Subnet Mask	The subnet mask of the network where the BDI is connected to. A subnet mask of 255.255.255.255 disables the gateway feature. Ask your network administrator for the correct subnet mask. If the BDI and the host are in the same subnet, it is not necessary to enter a subnet mask.
Default Gateway	Enter the IP address of the default gateway. Ask your network administrator for the correct gateway IP address. If the gateway feature is disabled, you may enter 255.255.255.255 or any other value.
Config - Host IP Address	Enter the IP address of the host with the configuration file. The configuration file is automatically read by the BDI2000 after every start-up.
Configuration file	Enter the full path and name of the configuration file. This file is read via TFTP. Keep in mind that TFTP has it's own root directory (usual /tftpboot). You can simply copy the configuration file to this directory and the use the file name without any path. For more information about TFTP use "man tftpd".

```
[root@LINUX_1 bdisetup]# ./bdisetup -c -p/dev/ttyS0 -b57 \
> -i151.120.25.101 \
> -h151.120.25.118 \
> -fevb405gp.cfg
Connecting to BDI loader
Writing network configuration
Writing init list and mode
Configuration passed
```

5. Check configuration and exit loader mode:
The BDI is in loader mode when there is no valid firmware loaded or you connect to it with the setup tool. While in loader mode, the Mode LED is flashing. The BDI will not respond to network requests while in loader mode. To exit loader mode, the "bdisetup -v -s" can be used. You may also power-off the BDI, wait some time (1min.) and power-on it again to exit loader mode.

```
[root@LINUX_1 bdisetup]# ./bdisetup -v -p/dev/ttyS0 -b57 -s
BDI Type : BDI2000 Rev.C (SN: 92152150)
Loader   : V1.05
Firmware : V1.03 bdiGDB for PPC400
Logic    : V1.01 PPC400
MAC      : 00-0c-01-92-15-21
IP Addr  : 151.120.25.101
Subnet   : 255.255.255.255
Gateway  : 255.255.255.255
Host IP  : 151.120.25.118
Config   : evb405gp.cfg
```

The Mode LED should go off, and you can try to connect to the BDI via Telnet.

```
[root@LINUX_1 bdisetup]# telnet 151.120.25.101
```

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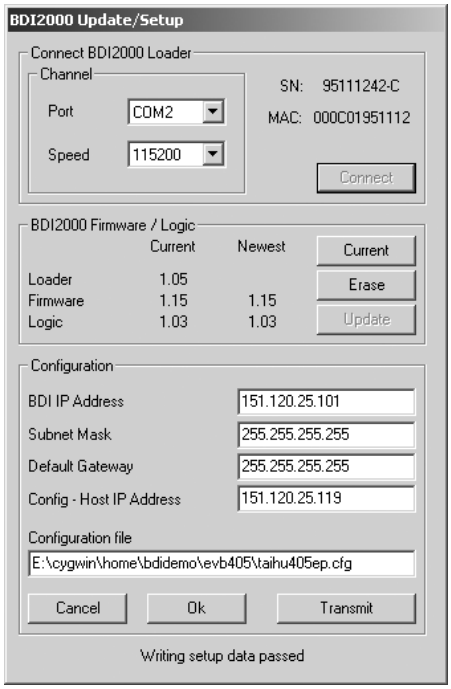
2.5.2 Configuration with a Windows host

First make sure that the BDI is properly connected (see Chapter 2.1 to 2.4).

To avoid data line conflicts, the BDI2000 must be disconnected from the target system while programming the logic for an other target CPU (see Chapter 2.1.1).



dialog box «BDI2000 Update/Setup»

Before you can use the BDI2000 together with the GNU debugger, you must store the initial configuration parameters in the BDI2000 flash memory. The following options allow you to do this:

Channel	Select the communication port where the BDI2000 is connected during this setup session.
Baudrate	Select the baudrate used to communicate with the BDI2000 loader during this setup session.
Connect	Click on this button to establish a connection with the BDI2000 loader. Once connected, the BDI2000 remains in loader mode until it is restarted or this dialog box is closed.
Current	Press this button to read back the current loaded BDI2000 software and logic versions. The current loader, firmware and logic version will be displayed.
Update	This button is only active if there is a newer firmware or logic version present in the execution directory of the bdiGDB setup software. Press this button to write the new firmware and/or logic into the BDI2000 flash memory / programmable logic.

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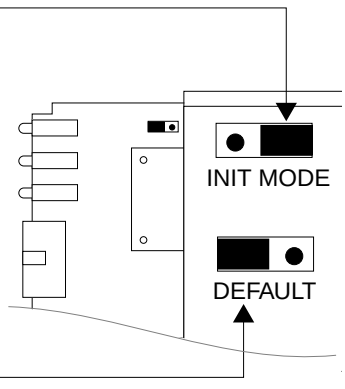
BDI IP Address	Enter the IP address for the BDI2000. Use the following format: xxx.xxx.xxx.xxx e.g.151.120.25.101 Ask your network administrator for assigning an IP address to this BDI2000. Every BDI2000 in your network needs a different IP address.
Subnet Mask	Enter the subnet mask of the network where the BDI is connected to. Use the following format: xxx.xxx.xxx.xxxe.g.255.255.255.0 A subnet mask of 255.255.255.255 disables the gateway feature. Ask your network administrator for the correct subnet mask.
Default Gateway	Enter the IP address of the default gateway. Ask your network administrator for the correct gateway IP address. If the gateway feature is disabled, you may enter 255.255.255.255 or any other value..
Config - Host IP Address	Enter the IP address of the host with the configuration file. The configuration file is automatically read by the BDI2000 after every start-up.
Configuration file	Enter the full path and name of the configuration file. e.g. D:\gnu\config\bdi\ads8260bdi.cnf For information about the syntax of the configuration file see the bdiGDB User manual. This name is transmitted to the TFTP server when reading the configuration file.
Transmit	Click on this button to store the configuration in the BDI2000 flash memory.

2.5.3 Recover procedure

In rare instances you may not be able to load the firmware in spite of a correctly connected BDI (error of the previous firmware in the flash memory). **Before carrying out the following procedure, check the possibilities in Appendix «Troubleshooting»**. In case you do not have any success with the tips there, do the following:

- Switch OFF the power supply for the BDI and open the unit as described in Appendix «Maintenance»
- Place the jumper in the **«INIT MODE»** position
- Connect the power cable or target cable if the BDI is powered from target system
- Switch ON the power supply for the BDI again and wait until the LED «MODE» blinks fast
- Turn the power supply OFF again
- Return the jumper to the **«DEFAULT»** position
- Reassemble the unit as described in Appendix «Maintenance»



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2.6 Testing the BDI2000 to host connection

After the initial setup is done, you can test the communication between the host and the BDI2000. There is no need for a target configuration file and no TFTP server is needed on the host.

- If not already done, connect the BDI2000 system to the network.
- Power-up the BDI2000.
- Start a Telnet client on the host and connect to the BDI2000 (the IP address you entered during initial configuration).
- If everything is okay, a sign on message like «BDI Debugger for Embedded PowerPC» and a list of the available commands should be displayed in the Telnet window.

2.7 TFTP server for Windows

The bdiGDB system uses TFTP to access the configuration file and to load the application program. Because there is no TFTP server bundled with Windows, Abatron provides a TFTP server application **tftpsrv.exe**. This WIN32 console application runs as normal user application (not as a system service).

Command line syntax: tftpsrv [p] [w] [dRootDirectory]

Without any parameter, the server starts in read-only mode. This means, only read access request from the client are granted. This is the normal working mode. The bdiGDB system needs only read access to the configuration and program files.

The parameter [p] enables protocol output to the console window. Try it.
The parameter [w] enables write accesses to the host file system.
The parameter [d] allows to define a root directory.

`tftpsrv p`	Starts the TFTP server and enables protocol output
`tftpsrv p w`	Starts the TFTP server, enables protocol output and write accesses are allowed.
`tftpsrv dC:\tftp\`	Starts the TFTP server and allows only access to files in C:\tftp and its subdirectories. As file name, use relative names. For example "bdi\mpc750.cfg" accesses "C:\tftp\bdi\mpc750.cfg"

You may enter the TFTP server into the Startup group so the server is started every time you login.

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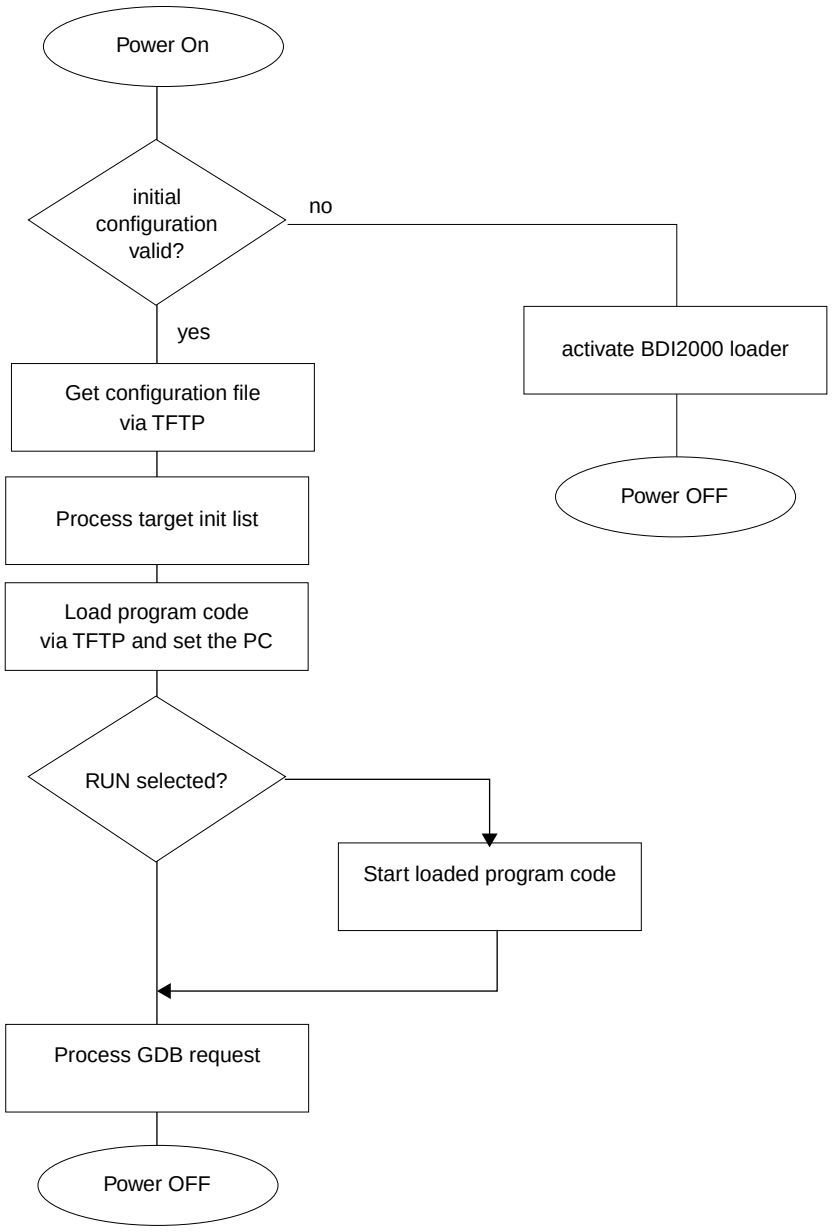
3 Using bdiGDB

3.1 Principle of operation

The firmware within the BDI handles the GDB request and accesses the target memory or registers via the JTAG interface. There is no need for any debug software on the target system. After loading the code via TFTP, debugging can begin at the very first assembler statement.

Whenever the BDI system is powered-up the following sequence starts:



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Breakpoints:
There are two breakpoint modes supported. One of them (SOFT) is implemented by replacing application code with a TRAP instruction. The other (HARD) uses the built in breakpoint logic. If HARD is used, only 2 (4 for PPC405/440) breakpoints can be active at the same time.
The following example selects SOFT as the breakpoint mode:

```
BREAKMODE   SOFT      ;SOFT or HARD, HARD uses PPC hardware breakpoints
```

All the time the application is suspended (i.e. caused by a breakpoint) the target processor remains freezed.

3.2 Configuration File

The configuration file is automatically read by the BDI after every power on.
The syntax of this file is as follows:

```
; comment
[part name]
identifier parameter1 parameter2 ..... parameterN  ; comment
identifier parameter1 parameter2 ..... parameterN
.....
[part name]
identifier parameter1 parameter2 ..... parameterN
identifier parameter1 parameter2 ..... parameterN
.....
              etc.
```

Numeric parameters can be entered as decimal (e.g. 700) or as hexadecimal (0x80000).

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3.2.1 Part [INIT]

The part [INIT] defines a list of commands which should be executed every time the target comes out of reset. The commands are used to get the target ready for loading the program file.

WGPR register value — Write value to the selected general purpose register.
- register — the register number 0 .. 31
- value — the value to write into the register
- Example: WGPR 0 5

WSPR register value — Write value to the selected special purpose register.
- register — the register number
- value — the value to write into the register
- Example: WSPR 27 0x00001002 ; SRR1 : ME,RI

WDCR register value — Write value to the selected device control register.
- register — the register number
- value — the value to write into the register
- Example: WSR 0 0x00001002 ; SR0 :

WREG name value — Write value to the selected CPU register by name
- name — the register name (MSR,CR,XER,LR,CTR,SRR0,...)
- value — the value to write into the register
- Example: WREG MSR 0x00001002

WM8 address value — Write a byte (8bit) to the selected memory place.
- address — the memory address
- value — the value to write to the target memory
- Example: WM8 0xFFFFFA21 0x04 ; SYPCR: watchdog disable ...

WM16 address value — Write a half word (16bit) to the selected memory place.
- address — the memory address
- value — the value to write to the target memory
- Example: WM16 0x02200200 0x0002 ; TBSCR

WM32 address value — Write a word (32bit) to the selected memory place.
- address — the memory address
- value — the value to write to the target memory
- Example: WM32 0x02200000 0x01632440 ; SIUMCR

DELAY value — Delay for the selected time. A delay may be necessary to let the clock PLL lock again after a new clock rate is selected.
- value — the delay time in milliseconds (1...30000)
- Example: DELAY 500 ; delay for 0.5 seconds

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MMAP start end

Because a memory access to an invalid memory space via JTAG leads to a deadlock, this entry can be used to define up to 32 valid memory ranges. If at least one memory range is defined, the BDI checks against this range(s) and avoids accessing of not mapped memory ranges.

start	the start address of a valid memory range
end	the end address of this memory range

Example: MMAP 0xFFE00000 0xFFFFFFFF ;Boot ROM

WTLB epn rpn

Only for PPC440: Adds an entry to the TLB array. For parameter description see below. A TLB entry can also be addd via a Telnet command (enter WTLB at the telnet for a description).

epn	the effective page number, size and WIMG flags
value	the real page number and access rights

Example: WTLB 0xF0000095 0x1F00003F ;Boot Space 256MB

Adding entries to the PPC440 TLB:
For PPC440 targets, it is necessary to setup the TLB before memory can be accessed. This is because on a PPC440 the MMU is always enabled. The init list entry WTLB allows an initial setup of the TLB array. The first WTLB entry clears also the whole TLB array.

The epn parameter defines the effective page number, endian, space, size and WIMG flags:

```
+----------------------+-+-+----+----+
|          EPN         |E|S|SIZE|WIMG|
+----------------------+-+-+----+----+
           22           1 1  4    4
```

The rpn parameter defines the real page number and access rights:

```
+----+-----------------------+------+
|ERPN|          RPN          |XWRXWR|
+----+-----------------------+------+
  4              22              6
```

Not all fields of a TLB entry are defined with the above values. The other values except the valid bit are implicit set to zero. The XWRXWR field starts with the user access rights. See also PPC440 user's manual part "Memory Management".

The following example clears the TLB and adds two entries to access ROM and SDRAM:

```
[INIT]
; Setup TLB
WTLB    0xF0000095  0x1F00003F  ;Boot Space 256MB, cache inhibited, guarded
WTLB    0x00000098  0x0000003F  ;SDRAM 256MB @0x00000000, write-through
```

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3.2.2 Part [TARGET]

The part [TARGET] defines some target specific values.

CPUTYPE type [FPU]

This value gives the BDI information about the connected CPU. Add FPU for chips with integrated floating point unit. Accessing FP registers needs a workspace in target RAM. See WORKSPACE parameter.
Note: For a PPC440GX it is necessary to define also SCANMISC 8

type	The CPU type from the following list: 401, 403, 405, 440
Example:	CPUTYPE 405

JTAGCLOCK value

With this value you can select the JTAG clock rate the BDI2000 uses when communication with the target CPU.

value	0 = 16.6 MHz	7 = 50 kHz
	1 = 8.3 MHz	8 = 20 kHz
	2 = 4.1 MHz	9 = 10 kHz
	3 = 1.0 MHz	10 = 5 kHz
	4 = 500 kHz	
	5 = 200 kHz	
	6 = 100 kHz	
Example:	CLOCK 1 ; JTAG clock is 8.3 MHz	

RESET type

Defines the reset type the BDI uses when reseting the target via the JTAG debug port. For more information see PPC4xx manuals.

type	NONE, CORE, CHIP, SYSTEM (default) HARD (via debug connector pin 13)
Example:	RESET CHIP ; IOP480 does not support system reset

WAKEUP time

This entry in the init list allows to define a delay time (in ms) the BDI inserts between forcing a target reset and starting communicating with the target.

time	the delay time in milliseconds
Example:	WAKEUP 3000 ; insert 3sec wake-up time

BDIMODE mode [param]

This parameter selects the BDI debugging mode. The following modes are supported:

LOADONLY	Loads and starts the application core. No debugging via JTAG port.
AGENT	The debug agent runs within the BDI. There is no need for any debug software on the target. This mode accepts a second parameter. If RUN is entered as a second parameter, the loaded application will be started immediately, otherwise only the PC is set and BDI waits for GDB requests.
Example:	BDIMODE AGENT

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STARTUP mode [runtime] This parameter selects the target startup mode. The following modes are supported:

RESET	This default mode forces the target to debug mode immediately out of reset. No code is executed after reset.
STOP	In this mode, the BDI lets the target execute code for "runtime" milliseconds after reset. This mode is useful when monitor code should initialize the target system.
RUN	After reset, the target executes code until stopped by the Telnet "halt" command.
Example:	STARTUP STOP 3000 ; let the CPU run for 3 seconds

BREAKMODE mode This parameter defines how breakpoints are implemented. The current mode can also be changed via the Telnet interface

SOFT	This is the normal mode. Breakpoints are implemented by replacing code with a TRAP instruction.
HARD	In this mode, the PPC breakpoint hardware is used. Only 2 / 4 breakpoints at a time are supported.
Example:	BREAKMODE HARD

STEPMODE mode This parameter defines how single step (instruction step) is implemented. The alternate step mode (HWBP) is useful when stepping instructions that causes a TLB miss exception.

JTAG	This is the default mode. The step feature of the JTAG debug interface is used for single stepping.
HWBP	In this mode, one or two hardware breakpoints are used to implement single stepping. Use this mode when debugging a Linux kernel.
Example:	STEPMODE HWBP

REGLIST list With GDB version 5.0, the number of registers read from the target has been increased. Additional registers like SR's, BAT's and SPR's are requested when you select a specific PowerPC variant with the "set processor" command (see GDB source file rs6000-tdep.c). In order to be compatible with older GDB versions and to optimize the time spent to read registers, this parameter can be used. You can define which register group is really read from the target. By default STD and FPR are read and transferred. This default is compatible with older GDB versions. The following names are use to select a register group:

STD	The standard (old) register block. The FPR registers are not read from the target but transferred. You can't disable this register group.
FPR	The floating point registers are read and transferred.
SPR	The additional special purpose registers
AUX	currently not used
ALL	Include all register groups
Example:	REGLIST STD ; only standard registers

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VECTOR CATCH

When this line is present, the BDI catches all unhandled exceptions. Catching exceptions is only possible if the vector table is writable.

Example: VECTOR CATCH ; catch unhandled exception

MMU XLAT [kb]

The BDI supports Linux kernel debugging when MMU is on. If this line is present, the BDI assumes that all addresses received from GDB and Telnet are virtual addresses. The optional parameter defines the kernel virtual base address (default is 0xC0000000) and is used for default address translation. If necessary the BDI creates appropriate TLB entries before accessing memory based on information found in the kernel page table. For more information see also chapter "Embedded Linux MMU Support". If not zero, the 12 lower bits of "kb" defines the position of the page present bit in a page table entry. By default 0x002 (440: 0x001)is assumed for the page present bit. The position depends on the Linux kernel version.

kb The kernel virtual base address (KERNELBASE)

Example: MMU XLAT ;enable support for virtual addresses
MMU XLAT 0xC0000020 ; page present bit is 0x020

PTBASE addr

This parameter defines the physical memory address where the BDI looks for the virtual address of the array with the two page table pointers. For more information see also chapter "Embedded Linux MMU Support".

addr Physical address of the memory used to store the virtual address of the array with the two page table pointers.

Example: PTBASE 0xf0

SIO port [baudrate]

When this line is present, a TCP/IP channel is routed to the BDI's RS232 connector. The port parameter defines the TCP port used for this BDI to host communication. You may choose any port except 0 and the default Telnet port (23). On the host, open a Telnet session using this port. Now you should see the UART output in this Telnet session. You can use the normal Telnet connection to the BDI in parallel, they work completely independent. Also input to the UART is implemented.

port The TCP/IP port used for the host communication.

baudrate The BDI supports 2400 ... 115200 baud

Example: SIO 7 9600 ;TCP port for virtual IO

WORKSPACE address

In order to access the floating-point registers, the BDI needs a workspace of 8 bytes in target RAM. Enter the base address of this RAM area.

address the address of the RAM area

Example: WORKSPACE 0x00000000

HALT [HIGH | LOW]

With this parameter it is possible to define if the HALT signal is active low (default) or active high.

Example: HALT HIGH ;HALT signal is active high

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Daisy chained JTAG devices:
For PPC4xx targets, the BDI can also handle systems with multiple devices connected to the JTAG scan chain. In order to put the other devices into BYPASS mode and to count for the additional bypass registers, the BDI needs some information about the scan chain layout. Enter the number (count) and total instruction register (irlen) length of the devices present before the PPC4xx chip (Predecessor). Enter the appropriate information also for the devices following the PPC4xx chip (Successor):

SCANPRED count irlen — This value gives the BDI information about JTAG devices present before the PPC4xx chip in the JTAG scan chain.

count	The number of preceding devices (0 ... 31)
irlen	The sum of the length of all preceding instruction registers (IR) (0 ... 1024)
Example:	SCANPRED 1 8 ; one device with an IR length of 8

SCANSUCC count irlen — This value gives the BDI information about JTAG devices present after the PPC4xx chip in the JTAG scan chain.

count	The number of succeeding devices (0 ... 31)
irlen	The sum of the length of all succeeding instruction registers (IR) (0 ... 1024)
Example:	SCANSUCC 2 12 ; two device with an IR length of 8+4

SCANMISC len val pos — This option has been added to support Xilinx Virtex-II Pro 405 cores. The IR length of a 405 core is 4 (instead of 7) and if the FPGA JTAG is daisy chained ,it needs a special IR value (not bypass). Also the FPGA has actually no bypass register if IR is loaded with 100000 .

len	The length of the 405 IR register (default is 7)
val	The IR value for the device(s) connected after the device under test. Only 8 bits can be defined. Default is 0xFF (bypass).
pos	The position of the LSB of special IR value. The number of bits in the scan chain after the LSB (default is 0).
Example:	SCANMISC 4 0xE0 ; IR len = 4, IR lsb = 11100000 SCANMISC 8 ; PPC440GX has 8 bit IR length

The following example shows a configuration for the a Xilinx Virtex-II Pro with one 405 daisy chained with the FPGA JTAG (405-FPGA):

```
SCANPRED    0   0
SCANSUCC    0   6       ;6 (FPGA)
SCANMISC    4   0xE0    ;IR length = 4, IR LSB = ..100000
```

The following example shows a configuration for the a Xilinx Virtex-II Pro with four 405 daisy chained with the FPGA JTAG (405-**405**-405-405-FPGA). The second 405 is selected for debugging :

```
SCANPRED    1   4       ;4 (405)
SCANSUCC    2   14      ;8 (2*405) + 6 (FPGA)
SCANMISC    4   0xE0    ;IR length = 4, IR LSB = ..100000
```

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Xilinx Virtex-II Pro JTAG configurations with FPGA in scan chain :

```
405-FPGA:
SCANPRED  0 0
SCANSUCC  0 6    ;6 (FPGA)
SCANMISC  4 0xE0 ;IR length = 4, IR LSB = ..100000


405-405-FPGA:
SCANPRED  0 0
SCANSUCC  1 10   ;4 (405) + 6 (FPGA)
SCANMISC  4 0xE0 ;IR length = 4, IR LSB = ..100000


405-405-FPGA:
SCANPRED  1 4    ;4 (405)
SCANSUCC  0 6    ;6 (FPGA)
SCANMISC  4 0xE0 ;IR length = 4, IR LSB = ..100000


405-405-405-405-FPGA:
SCANPRED  0 0
SCANSUCC  3 18   ;12 (3*405) + 6 (FPGA)
SCANMISC  4 0xE0 ;IR length = 4, IR LSB = ..100000


405-405-405-405-FPGA:
SCANPRED  1 4    ;4 (405)
SCANSUCC  2 14   ;8 (2*405) + 6 (FPGA)
SCANMISC  4 0xE0 ;IR length = 4, IR LSB = ..100000


405-405-405-405-FPGA:
SCANPRED  2 8    ;8 (2*405)
SCANSUCC  1 10   ;4 (405) + 6 (FPGA)
SCANMISC  4 0xE0 ;IR length = 4, IR LSB = ..100000


405-405-405-405-FPGA:
SCANPRED  3 12   ;12 (3*405)
SCANSUCC  0 6    ;6 (FPGA)
SCANMISC  4 0xE0 ;IR length = 4, IR LSB = ..100000
```

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Xilinx Virtex-II Pro JTAG configurations without FPGA in scan chain :

405:
```
SCANPRED  0 0
SCANSUCC  0 0
SCANMISC  4      ;IR length = 4
```

405-405:
```
SCANPRED  0 0
SCANSUCC  1 4    ;4 (1*405)
SCANMISC  4      ;IR length = 4
```

405-**405**:
```
SCANPRED  1 4    ;4 (1*405)
SCANSUCC  0 0
SCANMISC  4      ;IR length = 4
```

405-405-405-405:
```
SCANPRED  0 0
SCANSUCC  3 12   ;12 (3*405)
SCANMISC  4      ;IR length = 4
```

405-**405**-405-405:
```
SCANPRED  1 4    ;4 (1*405)
SCANSUCC  2 8    ;8 (2*405)
SCANMISC  4      ;IR length = 4
```

405-405-**405**-405:
```
SCANPRED  2 8    ;8 (2*405)
SCANSUCC  1 4    ;4 (1*405)
SCANMISC  4      ;IR length = 4
```

405-405-405-**405**:
```
SCANPRED  3 12   ;12 (3*405)
SCANSUCC  0 0
SCANMISC  4      ;IR length = 4
```

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3.2.3 Part [HOST]

The part [HOST] defines some host specific values.

IP ipaddress

The IP address of the host.

ipaddress	the IP address in the form xxx.xxx.xxx.xxx
Example:	IP 151.120.25.100

FILE filename

The default name of the file that is loaded into RAM using the Telnet 'load' command. This name is used to access the file via TFTP. If the filename starts with a $, this $ is replace with the path of the configuration file name.

filename	the filename including the full path or $ for relative path.
Example:	FILE F:\gnu\demo\ppc\test.elf FILE $test.elf

FORMAT format [offset]

The format of the image file and an optional load address offset. Currently S-record, a.out and ELF formats are supported. If the image is already stored in ROM on the target, select ROM as the format. The optional parameter "offset" is added to any load address read from the image file.

format	SREC, AOUT, ELF, IMAGE* or ROM
Example:	FORMAT ELF FORMAT ELF 0x10000

LOAD mode

In Agent mode, this parameters defines if the code is loaded automatically after every reset.

mode	AUTO, MANUAL
Example:	LOAD MANUAL

START address

The address where to start the program file. If this value is not defined and the core is not in ROM, the address is taken from the image file. If this value is not defined and the core is already in ROM, the PC will not be set before starting the program file. This means, the program starts at the normal reset address (0xFFFFFFFC).

address	the address where to start the program file
Example:	START 0x1000

DEBUGPORT port

The TCP port GDB uses to access the target.

port	the TCP port number (default = 2001)
Example:	DEBUGPORT 2001

* Special IMAGE load format:
The IMAGE format is a special version of the ELF format used to load a Linux boot image into target memory. When this format is selected, the BDI loads not only the loadable segment as defined in the Program Header, it also loads the rest of the file up to the Section Header Table. The relationship between load address and file offset will be maintained throughout this process. This way, the compressed Linux image and a optional RAM disk image will also be loaded.

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PROMPT string

This entry defines a new Telnet prompt. The current prompt can also be changed via the Telnet interface.

Example: PROMPT 440GX>

DUMP filename

The default file name used for the Telnet DUMP command.

filename the filename including the full path

Example: DUMP dump.bin

TELNET mode

By default the BDI sends echoes for the received characters and supports command history and line editing. If it should not send echoes and let the Telnet client in "line mode", add this entry to the configuration file.

mode ECHO (default), NOECHO or LINE

Example: TELNET NOECHO ; use old line mode

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3.2.4 Part [FLASH]

The Telnet interface supports programming and erasing of flash memories. The bdiGDB system has to know which type of flash is used, how the chip(s) are connected to the CPU and which sectors to erase in case the ERASE command is entered without any parameter.

CHIPTYPE type — This parameter defines the type of flash used. It is used to select the correct programming algorithm.

format	AM29F, AM29BX8, AM29BX16, I28BX8, I28BX16, AT49, AT49X8, AT49X16, STRATAX8, STRATAX16, MIRROR, MIRRORX8, MIRRORX16, M58X32, AM29DX16, AM29DX32
Example:	CHIPTYPE AM29F

CHIPSIZE size — The size of **one** flash chip in bytes (e.g. AM29F010 = 0x20000). This value is used to calculate the starting address of the current flash memory bank.

size	the size of one flash chip in bytes
Example:	CHIPSIZE 0x80000

BUSWIDTH width [PLXFIX] — Enter the width of the memory bus that leads to the flash chips. Do not enter the width of the flash chip itself. The parameter CHIPTYPE carries the information about the number of data lines connected to one flash chip. For example, enter 16 if you are using two AM29F010 to build a 16bit flash memory bank. The additional parameter PLXFIX is necessary if you program AMD/Atmel flashes with a PLX IOP480 target system.

with	the width of the flash memory bus in bits (8 | 16 | 32)
Example:	BUSWIDTH 16

FILE filename — The default name of the file that is programmed into flash using the Telnet 'prog' command. This name is used to access the file via TFTP. If the filename starts with a $, this $ is replace with the path of the configuration file name. This name may be overridden interactively at the Telnet interface.

filename	the filename including the full path or $ for relative path.
Example:	FILE F:\gnu\ppc\bootrom.hex FILE $bootrom.hex

FORMAT format [offset] — The format of the file and an optional address offset. The optional parameter "offset" is added to any load address read from the program file.

format	SREC, BIN, AOUT, ELF or IMAGE
Example:	FORMAT SREC FORMAT ELF 0x10000

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WORKSPACE address

If a workspace is defined, the BDI uses a faster programming algorithm that runs out of RAM on the target system. Otherwise, the algorithm is processed within the BDI. The workspace is used for a 1kByte data buffer and to store the algorithm code. There must be at least 2kBytes of RAM available for this purpose.

address	the address of the RAM area
Example:	WORKSPACE 0x00000000

ERASE addr [increment count] [mode [wait]]

The flash memory may be individually erased or unlocked via the Telnet interface. In order to make erasing of multiple flash sectors easier, you can enter an erase list. All entries in the erase list will be processed if you enter ERASE at the Telnet prompt without any parameter. This list is also used if you enter UNLOCK at the Telnet without any parameters. With the "increment" and "count" option you can erase multiple equal sized sectors with one entry in the erase list.

address	Address of the flash sector, block or chip to erase
increment	If present, the address offset to the next flash sector
count	If present, the number of equal sized sectors to erase
mode	BLOCK, CHIP, UNLOCK Without this optional parameter, the BDI executes a sector erase. If supported by the chip, you can also specify a block or chip erase. If UNLOCK is defined, this entry is also part of the unlock list. This unlock list is processed if the Telnet UNLOCK command is entered without any parameters.
wait	The wait time in ms is only used for the unlock mode. After starting the flash unlock, the BDI waits until it processes the next entry.
Example:	ERASE 0xff040000 ;erase sector 4 of flash ERASE 0xff060000 ;erase sector 6 of flash ERASE 0xff000000 CHIP ;erase whole chip(s) ERASE 0xff010000 UNLOCK 100 ;unlock, wait 100ms ERASE 0xff000000 0x10000 7 ; erase 7 sectors

Example for the PPC405 evaluation board flash memory:

```
[FLASH]
WORKSPACE   0x00004000  ;workspace in target RAM for fast programming algorithm
CHIPTYPE    AM29F       ;Flash type
CHIPSIZE    0x80000     ;The size of one flash chip in bytes (AM29F040 = 0x80000)
BUSWIDTH    8           ;The width of the flash memory bus in bits (8 | 16 | 32)
FILE        E:\cygnus\root\usr\demo\evb405\evb405gp.sss  ;The file to program
ERASE       0xFFF80000  ;erase sector 0 of flash in U7 (AM29F040)
ERASE       0xFFF90000  ;erase sector 1 of flash
ERASE       0xFFFA0000  ;erase sector 2 of flash
```

the above erase list maybe replaces with:

```
ERASE          0xFFF80000 0x10000 3 ;erase 3 sectors
```

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Supported Flash Memories:
There are currently 3 standard flash algorithm supported. The AMD, Intel and Atmel AT49 algorithm. Almost all currently available flash memories can be programmed with one of this algorithm. The flash type selects the appropriate algorithm and gives additional information about the used flash.

For 8bit only flash:	AM29F (MIRROR), I28BX8, AT49
For 8/16 bit flash in 8bit mode:	AM29BX8 (MIRRORX8), I28BX8 (STRATAX8), AT49X8
For 8/16 bit flash in 16bit mode:	AM29BX16 (MIRRORX16), I28BX16 (STRATAX16), AT49X16
For 16bit only flash:	AM29BX16, I28BX16, AT49X16
For 16/32 bit flash in 16bit mode:	AM29DX16
For 16/32 bit flash in 32bit mode:	AM29DX32
For 32bit only flash:	M58X32

The AMD and AT49 algorithm are almost the same. The only difference is, that the AT49 algorithm does not check for the AMD status bit 5 (Exceeded Timing Limits).
Only the AMD and AT49 algorithm support chip erase. Block erase is only supported with the AT49 algorithm. If the algorithm does not support the selected mode, sector erase is performed. If the chip does not support the selected mode, erasing will fail. The erase command sequence is different only in the 6th write cycle. Depending on the selected mode, the following data is written in this cycle (see also flash data sheets): 0x10 for chip erase, 0x30 for sector erase, 0x50 for block erase.
To speed up programming of Intel Strata Flash and AMD MirrorBit Flash, an additional algorithm is implemented that makes use of the write buffer. This algorithm needs a workspace, otherwise the standard Intel/AMD algorithm is used.

The following table shows some examples:

Flash	x 8	x 16	x 32	Chipsize
Am29F010	AM29F	-	-	0x020000
Am29F800B	AM29BX8	AM29BX16	-	0x100000
Am29DL323C	AM29BX8	AM29BX16	-	0x400000
Am29PDL128G	-	AM29DX16	AM29DX32	0x01000000
Intel 28F032B3	I28BX8	-	-	0x400000
Intel 28F640J3A	STRATAX8	STRATAX16	-	0x800000
Intel 28F320C3	-	I28BX16	-	0x400000
AT49BV040	AT49	-	-	0x080000
AT49BV1614	AT49X8	AT49X16	-	0x200000
M58BW016BT	-	-	M58X32	0x200000
SST39VF160	-	AT49X16	-	0x200000
Am29LV320M	MIRRORX8	MIRRORX16	-	0x400000

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Note:
Some Intel flash chips (e.g. 28F800C3, 28F160C3, 28F320C3) power-up with all blocks in locked state. In order to erase/program those flash chips, use the init list to unlock the appropriate blocks:

```
WM16    0xFFF00000    0x0060        unlock block 0
WM16    0xFFF00000    0x00D0
WM16    0xFFF10000    0x0060        unlock block 1
WM16    0xFFF10000    0x00D0
        ....
WM16    0xFFF00000    0xFFFF        select read mode
```

or use the Telnet "unlock" command:

```
UNLOCK [<addr> [<delay>]]
```

addr	This is the address of the sector (block) to unlock
delay	A delay time in milliseconds the BDI waits after sending the unlock command to the flash. For example, clearing all lock-bits of an Intel J3 Strata flash takes up to 0.7 seconds.

If "unlock" is used without any parameter, all sectors in the erase list with the UNLOCK option are processed.

To clear all lock-bits of an Intel J3 Strata flash use for example:

```
BDI> unlock 0xFF000000 1000
```

To erase or unlock multiple, continuos flash sectors (blocks) of the same size, the following Telnet commands can be used:

```
ERASE  <addr> <step> <count>
UNLOCK <addr> <step> <count>
```

addr	This is the address of the first sector to erase or unlock.
step	This value is added to the last used address in order to get to the next sector. In other words, this is the size of one sector in bytes.
count	The number of sectors to erase or unlock.

The following example unlocks all 256 sectors of an Intel Strata flash (28F256K3) that is mapped to 0x00000000. In case there are two flash chips to get a 32bit system, double the "step" parameter.

```
BDI> unlock 0x00000000 0x20000 256
```

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3.2.5 Part [REGS]

In order to make it easier to access target registers via the Telnet interface, the BDI can read in a register definition file. In this file, the user defines a name for the register and how the BDI should access it (e.g. as memory mapped, memory mapped with offset, ...). The name of the register definition file and information for different registers type has to be defined in the configuration file.
The register name, type, address/offset/number and size are defined in a separate register definition file.

An entry in the register definition file has the following syntax:

```
name    type    addr    [size [SWAP]]
```

name	The name of the register (max. 15 characters)
type	The register type
addr	The address, offset or number of the register
size	The size (8, 16, 32) of the register (default is 32)
SWAP	If present, the bytes of a 16bit or 32bit register are swapped. This is useful to access little endian ordered registers (e.g. MPC8240 configuration registers).

GPR	General purpose register
SPR	Special purpose register
DCR	Device control register
MM	Absolute direct memory mapped register
DMM1...DMM4	Relative direct memory mapped register
IMM1...IMM4	Indirect memory mapped register
IDCR1...IDCR8	Indirect accessed device control register

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The following entries are supported in the [REGS] part of the configuration file:

FILE filename

The name of the register definition file. This name is used to access the file via TFTP. If the filename starts with a $, this $ is replace with the path of the configuration file name. The file is loaded once during BDI startup.

filename	the filename including the full path
Example:	FILE C:\bdi\regs\ppc405gp.def

DMMn base

This defines the base address of direct memory mapped registers. This base address is added to the individual offset of the register.

base	the base address
Example:	DMM1 0x01000

IMMn addr data

This defines the addresses of the memory mapped address and data registers of indirect memory mapped registers. The address of a IMMn register is first written to "addr" and then the register value is access using "data" as address.

addr	the address of the Address register
data	the address of the Data register
Example:	IMM1 0x04700000 0x04700004

IDCRn addr data

This defines the numbers of the address and data DCR of indirectly accessed DCR's. The address of an IDCRn register is first written to "Addr-DCR" and then the register value is access using the "Data-DCR".

addr	the number of the Address DCR
data	the number of the Data DCR
Example:	IDCR1 16 17 ;MEMCFGADR and MEMCFGDATA

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Example for a register definition (PPC405GP):

Entry in the configuration file:

```
[REGS]
IDCR1   0x010   0x011   ;MEMCFGADR and MEMCFGDATA
IDCR2   0x012   0x013   ;EBCCFGADR and EBCCFGDATA
IDCR3   0x014   0x015   ;KIAR and KIDR
FILE    E:\cygnus\root\usr\demo\evb405\reg405gp.def
```

The register definition file:

```
;name          type    addr          size
;-----------------------------------------
;
sp             GPR     1
;
;       Special Purpose Registers
;
ccr0            SPR     947
ctr             SPR     9
dac1            SPR     1014
dac2            SPR     1015
dbcr0           SPR     1010
dbcr1           SPR     957
dccr            SPR     1018
        ....
;
;       Directly Accessed DCR's
;
pesr            DCR     0x084
pear            DCR     0x086
pacr            DCR     0x087
gesr0           DCR     0x0A0
        ....
;
;       Indirectly Accessed DCR's
;
;       IDCR1 must be set to MEMCFGADR and MEMCFGDATA
;       IDCR2 must be set to EBCCFGADR and EBCCFGDATA
;       IDCR3 must be set to KIAR      and KIDR
;
besra           IDCR1   0x000
besrb           IDCR1   0x008
bear            IDCR1   0x010
mcopt1          IDCR1   0x020
rtr             IDCR1   0x030
        ....
;
;       Memory-Mapped Registers
;
pmm0la          MM      0xEF400000      32
pmm0ma          MM      0xEF400004      32
pmm0pcila       MM      0xEF400008      32
        ....
```

Now the defined registers can be accessed by name via the Telnet interface:

BDI> rd mcopt1
BDI> rm rtr 0x05f00000

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3.3 Debugging with GDB

Because the target agent runs within BDI, no debug support has to be linked to your application. There is also no need for any BDI specific changes in the application sources. Your application must be fully linked because no dynamic loading is supported.

3.3.1 Target setup

Target initialization may be done at two places. First with the BDI configuration file, second within the application. The setup in the configuration file must at least enable access to the target memory where the application will be loaded. Disable the watchdog and setting the CPU clock rate should also be done with the BDI configuration file. Application specific initializations like setting the timer rate are best located in the application startup sequence.

3.3.2 Connecting to the target

As soon as the target comes out of reset, BDI initializes it and loads your application code. If RUN is selected, the application is immediately started, otherwise only the target PC is set. BDI now waits for GDB request from the debugger running on the host.

After starting the debugger, it must be connected to the remote target. This can be done with the following command at the GDB prompt:

```
(gdb)target remote bdi2000:2001
```

bdi2000	This stands for an IP address. The HOST file must have an appropriate entry. You may also use an IP address in the form xxx.xxx.xxx.xxx
2001	This is the TCP port used to communicate with the BDI

If not already suspended, this stops the execution of application code and the target CPU changes to background debug mode.
Remember, every time the application is suspended, the target CPU is freezed. During this time, no hardware interrupts will be processed.

Note: For convenience, the GDB detach command triggers a target reset sequence in the BDI.

```
(gdb)...
(gdb)detach
... Wait until BDI has resetet the target and reloaded the image
(gdb)target remote bdi2000:2001
```

Note:
After loading a program to the target you cannot use the GDB "*run*" command to start execution. You have to use the GDB "*continue*" command.

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3.3.3 Breakpoint Handling

GDB versions before V5.0:
GDB inserts breakpoints by replacing code via simple memory read / write commands. There is no command like "Set Breakpoint" defined in the GDB remote protocol. When breakpoint mode HARD is selected, the BDI checks the memory write commands for such hidden "Set Breakpoint" actions. If such a write is detected, the write is not performed and the BDI sets an appropriate hardware breakpoint. The BDI assumes that this is a "Set Breakpoint" action when memory write length is 4 bytes and the pattern to write is 0x7D821008 (tw 12,r2,r2).

GDB version V5.x:
GDB version 5.x uses the Z-packet to set breakpoints (watchpoints). For software breakpoints, the BDI replaces code with 0x7D821008 (tw 12,r2,r2). When breakpoint mode HARD is selected, the BDI sets an appropriate hardware breakpoint.

User controlled hardware breakpoints:
The PPC4xx has a special watchpoint / breakpoint hardware integrated. Normally the BDI controls this hardware in response to Telnet commands (BI, BDx) or when breakpoint mode HARD is selected. Via the Telnet commands BI and BDx, you cannot access all the features of the breakpoint hardware. Therefore the BDI assumes that the user will control / setup this breakpoint hardware as soon as DBCR (DBCR0 for 405/440) is written to. This way the debugger or the user via Telnet has full access to all features of this watchpoint / breakpoint hardware. A hardware breakpoint set via BI or BDx gives control back to the BDI.

3.3.4 GDB monitor command

The BDI supports the GDB V5.x "monitor" command. Telnet commands are executed and the Telnet output is returned to GDB. This way you can for example switch the BDI breakpoint mode from within your GDB session.

```
(gdb) target remote bdi2000:2001
Remote debugging using bdi2000:2001
0x10b2 in start ()
(gdb) monitor break
Breakpoint mode is SOFT
(gdb) mon break hard

(gdb) mon break
Breakpoint mode is HARD
(gdb)
```

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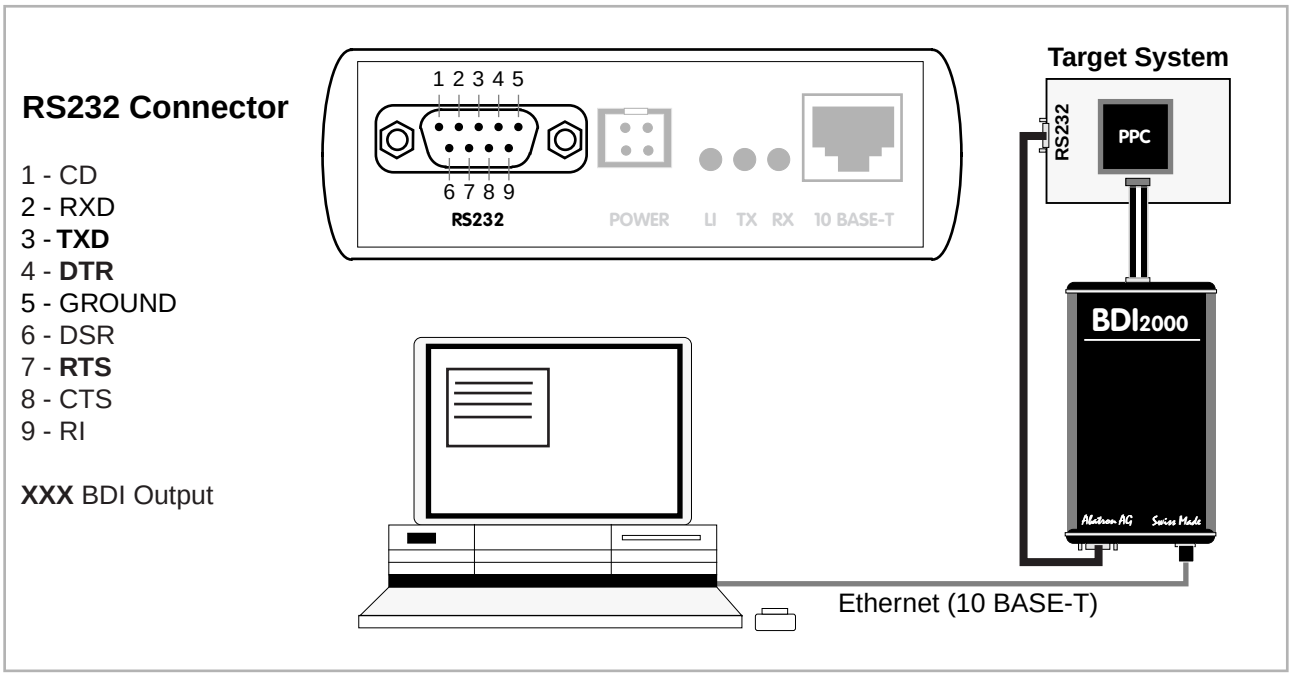
3.3.5 Target serial I/O via BDI

A RS232 port of the target can be connected to the RS232 port of the BDI2000. This way it is possible to access the target's serial I/O via a TCP/IP channel. For example, you can connect a Telnet session to the appropriate BDI2000 port. Connecting GDB to a GDB server (stub) running on the target should also be possible.



The configuration parameter "SIO" is used to enable this serial I/O routing.
The BDI asserts RTS and DTR when a TCP connection is established.

```
[TARGET]
....
SIO     7       9600            ;Enable SIO via TCP port 7 at 9600 baud
```

Warning!!!
Once SIO is enabled, connecting with the setup tool to update the firmware will fail. In this case either disable SIO first or disconnect the BDI from the LAN while updating the firmware.

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3.3.6 Embedded Linux MMU Support

The bdiGDB system supports Linux kernel debugging when MMU is on. The MMU configuration parameter enables this mode of operation. In this mode, all addresses received from GDB or Telnet are assumed to be virtual. Before the BDI accesses memory, it either translates this address into a physical one or creates an appropriate TLB entry based on information found in the kernel page tables. A new TLB entry is only added if there is not already a matching one present.

In order to search the page tables, the BDI needs to know the start addresses of the first level page tables. The configuration parameter PTBASE defines the physical address where the BDI looks for the address of an array with two addresses of first level page tables. The first one points normally to the kernel page table, the second one can point to the current user page table. As long as the base pointer or the first entry is zero, the BDI does only default translation.
Default translation maps addresses in the range KERNELBASE...(KERNELBASE + 0x0FFFFFFF) to 0x00000000...0x0FFFFFFF. The second page table is only searched if its address is not zero and there was no match in the first one.

The pointer stucture is as follows:

```
PTBASE (physical address) ->
       PTE pointer pointer(virtual or physical address) ->
              PTE kernel pointer (virtual or physical address)
              PTE user pointer (virtual or physical address)
```

Newer versions of "arch/ppc/kernel/head_4xx.S" support the automatic update of the BDI page table information structure. Search "head_4xx.S" for "abatron" and you will find the BDI specific extensions.

Extract from the configuration file:

```
[INIT]
......
WM32    0x000000f0      0x00000000      ;invalidate page table base


[TARGET]
....
STEPMODE       HWBP           ;JTAG or HWBP, HWPB uses one or two hardware breakpoints
MMU            XLAT           ;MMU support enabled
PTBASE         0x000000f0     ;here is the pointer to the page table pointers
```

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To debug the Linux kernel when MMU is enabled you may use the following load and startup sequence:

- Load the compressed linux image
- Set a hardware breakpoint with the Telnet at a point where MMU is enabled. For example at "start_kernel".
  BDI> BI 0xC0061550
- Start the code with GO at the Telnet
- The Linux kernel is decompressed and started
- The system should stop at the hardware breakpoint (e.g. at start_kernel)
- Disable the hardware breakpoint with the Telnet command CI.
- If not automatically done by the kernel, setup the page table pointers for the BDI.
- Start GDB with vmlinux as parameter
- Attach to the target
- Now you should be able to debug the Linux kernel

To setup the BDI page table information structure manually, set a hardware breakpoint at "start_kernel" and use the Telnet to write the address of "swapper_pg_dir" to the appropriate place.

```
BDI>bi 0xc0061550           /* set breakpoint at start_kernel */
BDI>go
..                          /* target stops at start_kernel */
BDI>ci
BDI>mm 0xf0 0xc00000f8      /* Let PTBASE point to an array of two pointers*/
BDI>mm 0xf8 0xc0057000      /* write address of swapper_pg_dir to first pointer */
BDI>mm 0xfc 0x00000000      /* clear second (user) pointer */
```

Note:
When searching the page table, the BDI needs to check the page present bit in a page table entry. For PPC4xx targets, the position of this bit has moved around in the past. By default the BDI assumes the following definition for the page present bit (see pgtable.h in your kernel sources):

```
405: #define _PAGE_PRESENT 0x002 /* software: PTE contains a translation */
440: #define _PAGE_PRESENT 0x001 /* software: PTE contains a translation */
```

If this does not match your version of "pgtable.h", use the 12 lower bits of the MMU XLAT parameter to define the correct bit position.

```
MMU XLAT 0xC0000040 ; page present bit is 0x040
```

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3.4 Telnet Interface

A Telnet server is integrated within the BDI. The Telnet channel is used by the BDI to output error messages and other information. Also some basic debug commands can be executed.

Telnet Debug features:

- Display and modify memory locations
- Display and modify general and special purpose registers
- Single step a code sequence
- Set hardware breakpoints
- Load a code file from any host
- Start / Stop program execution
- Programming and Erasing Flash memory

During debugging with GDB, the Telnet is mainly used to reboot the target (generate a hardware reset and reload the application code). It may be also useful during the first installation of the bdiGDB system or in case of special debug needs.

Example of a Telnet session:

```
BDI>res
- TARGET: processing user reset request
- TARGET: reseting target passed
- TARGET: processing target init list ....
- TARGET: processing target init list passed
BDI>info
    Target state      : debug mode
    Debug entry cause : trap instruction
    Current PC        : 0xfffffffc
    Current CR        : 0x00000000
    Current MSR       : 0x00000000
    Current LR        : 0x0001ba70
BDI>md 0
00000000 : 00000000 00000004 00000008 0000000c  ................
00000010 : 00000010 00000014 00000018 0000001c  ................
00000020 : 00000020 00000024 00000028 0000002c  ... ...$...(...,
00000030 : 00000030 00000034 00000038 0000003c  ...0...4...8...<
00000040 : 00000040 00000044 00000048 0000004c  ...@...D...H...L
              ....................
```

Notes:
The DUMP command uses TFTP to write a binary image to a host file. Writing via TFTP on a Linux/ Unix system is only possible if the file already exists and has public write access. Use "man tftpd" to get more information about the TFTP server on your host.
A PPC4xx target can be forced to debug mode in two different ways. HALT at the Telnet asserts the HALT pin to stop the processor. STOP at the Telnet uses the JTAG stop command. The HALT pin is deasserted with the next RESET or RUN. If a JTAG reset does not completely reset a target system (e.g. IOP480), the sequence Telnet HALT, press reset button, Telnet RESET can be used to force the target to debug mode immediately out of reset.

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The Telnet commands:

```
"MD    [<address>] [<count>]  display target memory as word (32bit)",
"MDH   [<address>] [<count>]  display target memory as half word (16bit)",
"MDB   [<address>] [<count>]  display target memory as byte (8bit)",
"DUMP  <addr> <size> [<file>] dump target memory to a file",
"MM    <addr> <value> [<cnt>] modify word(s) (32bit) in target memory",
"MMH   <addr> <value> [<cnt>] modify half word(s) (16bit) in target memory",
"MMB   <addr> <value> [<cnt>] modify byte(s) (8bit) in target memory",
"MC    [<address>] [<count>]  calculates a checksum over a memory range",
"MV                           verifies the last calculated checksum",
"RD    [<name>]               display general purpose or user defined register",
"RDUMP [<file>]               dump all user defined register to a file",
"RDSPR <number>               display special purpose register",
"RDDCR <number>               display device control register",
"RM    {<nbr>=<name>} <value> modify general purpose or user defined register",
"RMSPR <number>   <value>     modify special purpose register",
"RMDCR <number>   <value>     modify device control register",
"TLB   <from> [<to>]          display TLB entry",
"WTLB  <idx> <epn> <rpn>      write TLB entry (only PPC440)",
"DFLUSH [<addr>]              flush data cache (addr = cached memory address)",
"IFLUSH                       invalidate instruction cache",
"DCACHE <from> [<to>]         display L1 data cache (440: lines, 405: sets)",
"ICACHE <from> [<to>]         display L1 inst cache (440: lines, 405: sets)",
"BOOT                         reset the BDI and reload the configuration",
"RESET [HALT | RUN [time]]    reset the target system, change startup mode",
"BREAK [SOFT | HARD]          display or set current breakpoint mode",
"GO    [<pc>]                 set PC and start target system",
"GO    <n> <n> [<n>[<n>]]     start multiple cores in requested order",
"TI    [<pc>]                 trace on instuction (single step)",
"TC    [<pc>]                 trace on change of flow",
"HALT                         stop all cores via HALT pin",
"STOP  [<n>[<n>[<n>[<n>]]]]   stop core(s) via JTAG port (n = core number)",
"BI  <addr>                   set instruction breakpoint",
"CI  [<id>]                   clear instruction breakpoint(s)",
"BD  [R|W] <addr>             set data breakpoint (32bit access)",
"BDH [R|W] <addr>             set data breakpoint (16bit access)",
"BDB [R|W] <addr>             set data breakpoint ( 8bit access)",
"CD [<id>]                    clear data breakpoint(s)",
"INFO                         display information about the current state",
"LOAD   [<offset>] [<file> [<format>]] load program file to target memory",
"VERIFY [<offset>] [<file> [<format>]] verify a program file to target memory",
"PROG   [<offset>] [<file> [<format>]] program flash memory",
"                                     <format> : SREC or BIN or AOUT or ELF",
"ERASE  [<address> [<mode>]]  erase a flash memory sector, chip or block",
"                  <mode>  : CHIP, BLOCK or SECTOR (default is sector)",
"ERASE  <addr> <step> <count> erase multiple flash sectors",
"UNLOCK [<addr> [<delay>]]    unlock a flash sector",
"UNLOCK <addr> <step> <count> unlock multiple flash sectors",
"FLASH  <type> <size> <bus>   change flash configuration",
"DELAY  <ms>                  delay for a number of milliseconds",
"SELECT <core>                change the current core",
"HOST   <ip>                  change IP address of program file host",
"PROMPT <string>              defines a new prompt string",
"CONFIG                       display or update BDI configuration",
"CONFIG <file> [<hostIP> [<bdiIP> [<gateway> [<mask>]]]]",
"HELP                         display command list",
"JTAG                         switch to JTAG command mode",
"QUIT                         terminate the Telnet session"
```

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3.5 Multi-Core Support

The bdiGDB system supports concurrent debugging of up to 4 PPC4xx cores connected to the same JTAG scan chain. For every core you can start its own GDB session. The default port numbers used to attach the remote targets are 2001 ... 2004. In the Telnet you switch between the cores with the command "select <0..3>". In the configuration file, simply begin the line with the appropriate core number. If there is no #n in front of a line, the BDI assumes core #0.

The following example defines two PPC405 cores on the scan chain.

```
[TARGET]
JTAGCLOCK       0               ;use 16 MHz JTAG clock
WAKEUP          1000            ;give reset time to complete

;  405-405-FPGA
#0 CPUTYPE      405             ;the target CPU type
#0 SCANPRED     0 0
#0 SCANSUCC     1 10            ;4 (405) + 6 (FPGA)
#0 SCANMISC     4 0xE0          ;IR length = 4, IR LSB = ..100000
#0 BREAKMODE    SOFT            ;SOFT or HARD

;  405-405-FPGA:
#1 CPUTYPE      405             ;the target CPU type
#1 SCANPRED     1 4             ;4 (405)
#1 SCANSUCC     0 6             ;6 (FPGA)
#1 SCANMISC     4 0xE0          ;IR length = 4, IR LSB = ..100000
#1 BREAKMODE    SOFT            ;SOFT or HARD
```

In case there are additional JTAG devices after the Xilinx Virtex-II Pro device, the third parameter of SCANMISC is necessary.

```
;  (405-405-FPGA) - (2 devices with totel IR length 12):
#1 CPUTYPE      405             ;the target CPU type
#1 SCANPRED     1 4             ;4 (405)
#1 SCANSUCC     2 18            ;6 (FPGA)+ 12 (2 devices)
#1 SCANMISC     4 0xE0 12       ;IR length = 4, IR = ..100000111111111111
#1 BREAKMODE    SOFT            ;SOFT or HARD
```

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3.6 Low level JTAG mode

It is possible to switch to a mode where you can enter low level JTAG commands via the Telnet interface. You activate this mode via the Telnet "jtag" command. Once the BDI has entered this mode, a new set of Telnet commands is available.

```
"TRST    {0|1}                assert (1) or release (0) TRST",
"HALT    {0|1}                assert (1) or release (0) HALT",
"CLK     <count> <tms>        clock TAP with requested TMS value",
"RIR [+] <len>                read  IR, zero is scanned in",
"RDR [+] <len>                read  DR, zero is scanned in",
"WIR [+] <len> <...b2b1b0>    write IR, b0 is first scanned",
"WDR [+] <len> <...b2b1b0>    write DR, b0 is first scanned",
"XIR [+] <len> <...b2b1b0>    xchg  IR, b0 is first scanned",
"XDR [+] <len> <...b2b1b0>    xchg  DR, b0 is first scanned",
"                             +   : more data follows",
"                                   do not exit shift-IR/DR state",
"                             len : the number of bits 1..256",
"                             bx  : a data byte, two hex digits",
"RFILE <len> <file> [<succ>]  dump DR to file, zero is scanned in",
"WFILE <len> <file> [<pred>]  write DR from file",
"DELAY   <10...50000>         delay for n microseconds",
"HELP                         display JTAG command list",
"EXIT                         terminate JTAG mode"
```

Using this special JTAG mode is not necessary during normal debugging. Also using it interactively makes not much sense. This JTAG mode can be used by other tools that allow to program for example the FPGA within a Xilinx Virtex-II Pro. Abatron does not supply such tools.

Example:
Following a short session where I read all the ID codes from XC18V04 - XC18V04 - XC2VP20:

```
Core#0>jtag
JTAG>wir 30 3fbfbfc9
JTAG>rdr 96
050260930502609301266093
JTAG>rdr 96
050260930502609301266093
JTAG>rdr + 32
01266093
JTAG>rdr + 32
05026093
JTAG>rdr 32
05026093
JTAG>rdr 96
050260930502609301266093
JTAG>rfile 96 e:\temp\idcode.bin
```

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4 Specifications

Operating Voltage Limiting	5 VDC ± 0.25 V
Power Supply Current	typ. 500 mA max. 1000 mA
RS232 Interface: Baud Rates	9’600,19’200, 38’400, 57’600,115’200
Data Bits	8
Parity Bits	none
Stop Bits	1
Network Interface	10 BASE-T
Serial Transfer Rate between BDI and Target	up to 16 Mbit/s
Supported target voltage	1.8 – 5.0 V (3.0 – 5.0 V with Rev. B)
Operating Temperature	+ 5 °C ... +60 °C
Storage Temperature	-20 °C ... +65 °C
Relative Humidity (noncondensing)	<90 %rF
Size	190 x 110 x 35 mm
Weight (without cables)	420 g
Host Cable length (RS232)	2.5 m

Specifications subject to change without notice

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5 Environmental notice

Disposal of the equipment must be carried out at a designated disposal site.

6 Declaration of Conformity (CE)

CE

DECLARATION OF CONFORMITY

This declaration is valid for following product:

Type of device: BDM/JTAG Interface
Product name: BDI2000

The signing authorities state, that the above mentioned equipment meets the requirements for emission and immunity according to

EMC Directive 89/336/EEC

The evaluation procedure of conformity was assured according to the following standards:

EN 50081-2
EN 50082-2

This declaration of conformity is based on the test report no. QNL-E853-05-8-a of QUINEL, Zug, accredited according to EN 45001.

Manufacturer:

ABATRON AG
Stöckenstrasse 4
CH-6221 Rickenbach

Authority:

Max Vock
Marketing Director

Ruedi Dummermuth
Technical Director

Rickenbach, May 30, 1998

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7 Warranty

ABATRON Switzerland warrants the physical diskette, cable, BDI2000 and physical documentation to be free of defects in materials and workmanship for a period of 24 months following the date of purchase when used under normal conditions.

In the event of notification within the warranty period of defects in material or workmanship, ABATRON will replace defective diskette, cable, BDI2000 or documentation. The remedy for breach of this warranty shall be limited to replacement and shall not encompass any other damages, including but not limited loss of profit, special, incidental, consequential, or other similar claims.
ABATRON Switzerland specifically disclaims all other warranties- expressed or implied, including but not limited to implied warranties of merchantability and fitness for particular purposes - with respect to defects in the diskette, cable, BDI2000 and documentation, and the program license granted herein, including without limitation the operation of the program with respect to any particular application, use, or purposes. In no event shall ABATRON be liable for any loss of profit or any other commercial damage, including but not limited to special, incidental, consequential, or other damages.

Failure in handling which leads to defects are not covered under this warranty. The warranty is void under any self-made repair operation except exchanging the fuse.

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Appendices

A Troubleshooting

Problem
The firmware can not be loaded.

Possible reasons

- The BDI is not correctly connected with the target system (see chapter 2).
- The power supply of the target system is switched off or not in operating range (4.75 VDC ... 5.25 VDC) --> MODE LED is OFF or RED
- The built in fuse is damaged --> MODE LED is OFF
- The BDI is not correctly connected with the Host (see chapter 2).
- A wrong communication port (Com 1...Com 4) is selected.

Problem
No working with the target system (loading firmware is ok).

Possible reasons

- Wrong pin assignment (BDM/JTAG connector) of the target system (see chapter 2).
- Target system initialization is not correctly --> enter an appropriate target initialization list.
- An incorrect IP address was entered (BDI2000 configuration)
- BDM/JTAG signals from the target system are not correctly (short-circuit, break, ...).
- The target system is damaged.

Problem
Network processes do not function (loading the firmware was successful)

Possible reasons

- The BDI2000 is not connected or not correctly connected to the network (LAN cable or media converter)
- An incorrect IP address was entered (BDI2000 configuration)

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B Maintenance

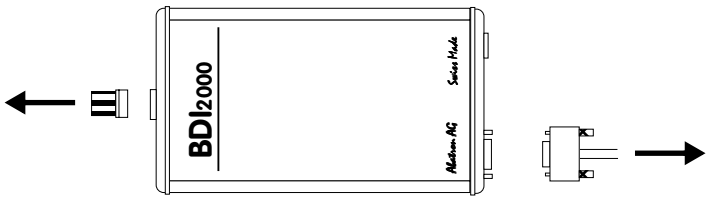
The BDI needs no special maintenance. Clean the housing with a mild detergent only. Solvents such as gasoline may damage it.

If the BDI is connected correctly and it is still not responding, then the built in fuse might be damaged (in cases where the device was used with wrong supply voltage or wrong polarity). To exchange the fuse or to perform special initialization, please proceed according to the following steps:

Observe precautions for handling (Electrostatic sensitive device)
Unplug the cables before opening the cover.
Use exact fuse replacement (Microfuse MSF 1.6 AF).

1

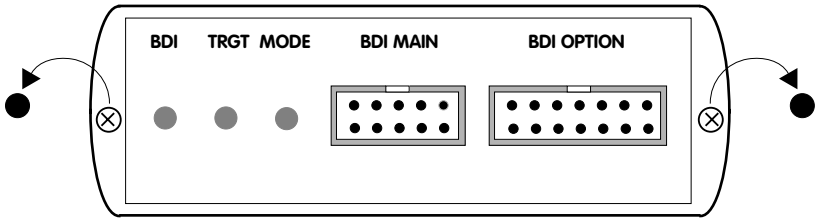
1.1 Unplug the cables



2

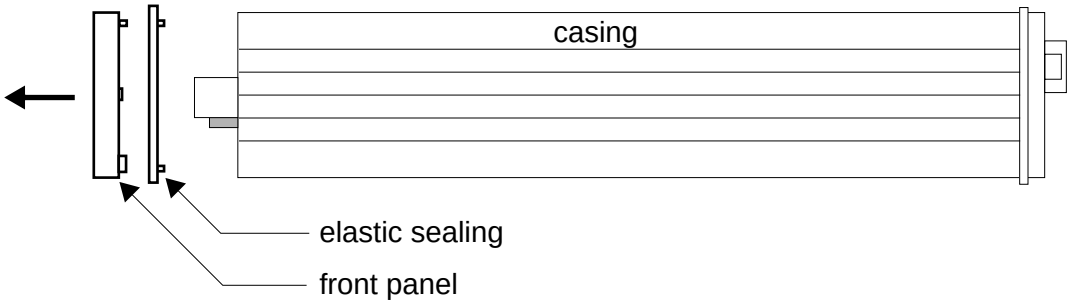
2.1 Remove the two plastic caps that cover the screws on target front side (e.g. with a small knife)

2.2 Remove the two screws that hold the front panel



3

3.1 While holding the casing, remove the front panel and the red elastig sealing



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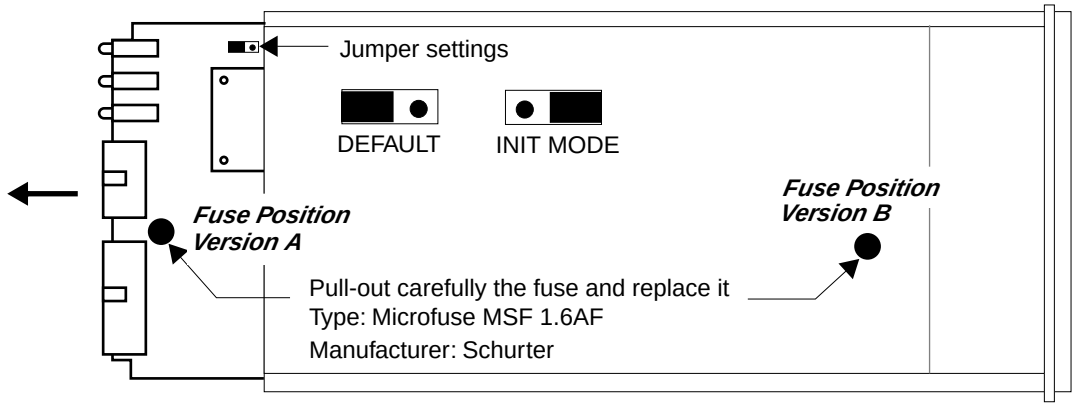
4

4.1 While holding the casing, slide carefully the print in position as shown in figure below

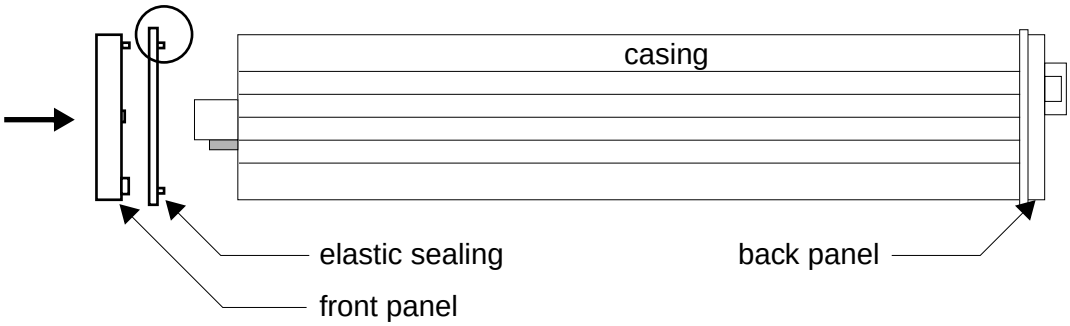


5

Reinstallation

5.1 Slide back carefully the print. Check that the LEDs align with the holes in the back panel.

5.2 Push carefully the front panel and the red elastig sealing on the casing. Check that the LEDs align with the holes in the front panel and that the position of the sealing is as shown in the figure below.



5.3 Mount the screws (do not overtighten it)

5.4 Mount the two plastic caps that cover the screws

5.5 Plug the cables

Observe precautions for handling (Electrostatic sensitive device)
Unplug the cables before opening the cover.
Use exact fuse replacement (Microfuse MSF 1.6 AF).

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